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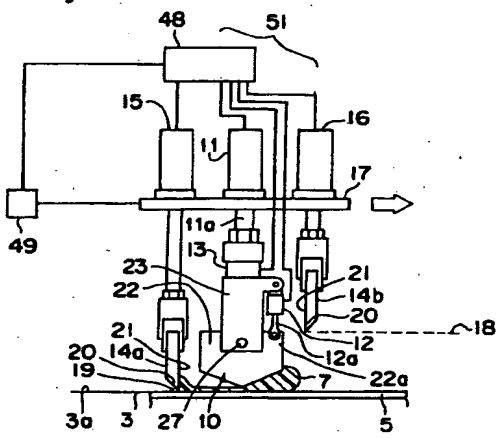
(54) Apparatus and method for printing solder paste

(57) A filling squeegee (10) and a scraping squeegee (14a,14b) are provided. The filling squeegee (10) is moved in a state without contact with a surface of a mask (3) thereby to fill a solder paste (7) in openings of the mask (3), then the unnecessary solder paste (7) on the surface of the mask (3) is scraped by the scraping squeegee (14a). The solder paste (7) is prevented from being filled in the openings improperly or scraped improperly even if a speed of the squeegee is increased, so that the solder paste (7) is printed stably on circuit boards (5).

Fig. 1



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Description

BACKGROUND OF THE INVENTION

The present invention relates to an apparatus and a method for printing, applying solder paste onto surfaces of circuit boards to be printed.

In the prior art of manufacturing electronic circuit boards, solder paste has been primarily used to solder electronic components such as chips or the like onto printed boards. A solder paste printing apparatus has been employed to print, apply the solder paste in a required pattern.

A squeegee head loaded to a conventional solder paste printing apparatus 100 is constituted, for instance, as shown in Fig. 20. Generally, a squeegee head 102 moves from left to right and from right to left in Fig. 20 alternately for every printed board 5 to print the solder paste. A right squeegee 101a is used for printing in the right direction, namely, from left to right in Fig. 20, and a left squeegee 101b is for printing in the opposite left direction.

An operation for printing the solder paste to the printed board 5 by the conventional solder paste printing apparatus 100 will be described with reference to Figs. 20-22. In Figs. 20-22, references respectively indicate: 3 a mask having openings 4 formed in a required pattern; 5 a printed board; 6 a land to which a solder paste 7 is printed; and 8 a solder resist. The above-mentioned required pattern of the mask 3 is a pattern in which openings 4 are formed corresponding to lands 6 on the printed board 5.

Firstly, in printing in the right direction, the printed board 5 is positioned and overlapped with the mask 3 so that the openings 4 agree with the lands 6. Thereafter, while the left squeegee 101b is kept raised, the right squeegee 101a is lowered to bring a squeegee front end part 103 in touch with a surface 3a of the mask 3 with a suitable printing pressure. In this state, the right squeegee 101a is linearly moved in the right direction, thereby to fill the solder paste 7 provided at the surface 3a of the mask 3 into the openings 4 of the mask 3. The printed board 5 is separated from the mask 3 after the right squeegee 101a is moved to the right end of the mask 3, when the printing is finished. Meanwhile, in the case of printing in the left direction, the printed board 5 is positioned and overlapped with the mask 3, similar to the above printing in the right direction. Then, the left squeegee 101b is descended while the right squeegee 101a is held up, to bring the squeegee front end part 103 in touch with the mask 3. The operation afterwards is the same as in the case of printing in the right direction. By repeating the operations in the right direction and left direction alternately for every printed board 5, the solder paste 7 is continuously printed, applied onto the lands 6 of each printed board 5 via the mask 3.

In the conventional solder paste printing apparatus 100, the squeegee 101a or 101b is moved while the front end part 103 of the squeegee is kept in touch with the surface 3a of the mask 3 with a suitable printing pressure. As is made clear from this fact, each of the conventional squeegees 101a, 101b executes two kinds of operations, i.e., a scraping operation of scraping the solder paste 7 at the surface 3a of the mask 3 and a filling operation of filling the solder paste 7 to openings 4 of the mask 3, which will be described with reference to Figs. 21 and 22.

Figs. 21 and 22 are enlarged views of the printing squeegee 101a, etc. when the printing is carried out in the right direction. As shown in Fig. 21, when the right squeegee 101a is descended to bring the front end part 103 in touch with the surface 3a of the mask 3 and moved linearly in the right direction, the right squeegee 101a reaching the solder paste 7 fed to the surface 3a of the mask 3 moves while scraping the solder paste. The scraped solder paste 7 flows accompanying a rotary movement called rolling as indicated by an arrow I in Fig. 22. At this time, a fluid pressure is generated inside the solder paste 7. When the right squeegee 101a moves further right to reach the opening 4 of the mask 3 in the above condition, the solder paste 7 is pressed into the openings 4 because of the above-described fluid pressure, in other words, the solder paste 7 is filled in the openings 4. A pressure with which the solder paste 7 is pressed into the openings 4 will be denoted as a "filling pressure" hereinbelow.

Supposing a coordinate system as shown in Fig. 23 to the printing squeegee 101a, when a viscosity of the solder paste 7 is η, an angle of the surface 3a of the mask 3 to a face 104 of the printing squeegee 101a facing the surface 3a (referred to as a "squeegee angle" hereinafter) is α, a speed of the moving squeegee 101a (referred to as a "squeegee speed") is v, it is known that a fluid pressure p produced inside the solder paste 7 is expressed by an equation below.

$$p=(2\eta v/r)*(A\sin\theta+B\cos\theta) \quad (1)$$

wherein r is an optional position in the polar coordinate system of Fig. 23, θ is an angle of the surface 3a of the mask 3 to the above r, $A=\sin^2\alpha/(\alpha^2-\sin^2\alpha)$ and $B=(\alpha-\sin\alpha*\cos\alpha)/(\alpha^2-\sin^2\alpha)$.

From the above expression (1), a fluid pressure distribution in the solder paste 7 and a pressure distribution at the face 104 of the printing squeegee 101a are as indicated in Fig. 24. Specifically, a shaded part 105 in Fig. 24 is where the fluid pressure p, namely, filling pressure is generated.

In the meantime, a print time for printing the solder paste is required to be reduced in the printing process from the viewpoint of improving productivity. However, if the squeegee speed v is made faster in order to shorten the print time in the conventional solder paste printing apparatus 100, the amount of the solder paste 7 filled in the openings 4 of the mask 3 becomes scarce as indicated in Fig. 25, resulting in printing failures with non-

filled parts 9 and hindering stable printing. The non-filled part 9 is not generally brought about, for example, if ink is printed in a method of screen printing, but is given rise to when a paste-like substance of a mixture of a high viscosity flux with powder solder, e.g., the solder paste 7 or the like is used. That is, the non-filled part 9 is caused by the powder solder. In other words, there is an issue that it is impossible to realize a reduction of the print time through an increase of the squeegee speed v in the conventional solder paste printing apparatus 100.

The non-filled part 9 resulting from an increase of the squeegee speed v is a phenomenon as follows. When the squeegee speed v is increased more than in the prior art, a time for the front end part 103 of the printing squeegee 101a to pass over the opening 4 is reduced. In consequence, a time for the solder paste 7 to be filled in the opening 4 (referred to as a "fill time") is naturally shortened. The filling pressure becomes maximum when r=0, i.e., at a contact point of the front end part 103 of the printing squeegee 101a and the surface 3a of the mask 3, as is understood from the expression (1) and Figs. 23 and 24. Although $p_r=p_\theta=\infty$ is theoretically held when r=0, the contact point is practically a stagnation point and accordingly shows a maximum value.

While the filling pressure itself is raised when the squeegee speed v is increased, a high pressure range is narrow as is seen from the pressure distribution of the shaded part of Fig. 24. In addition, since the front end part 103 passes over the opening 4 instantaneously, the fill time cannot be secured enough. As a result of this, the non-filled part 9 is formed.

In order to prevent an occurrence of the non-filled parts 9, from the expression (1), it can be considered that the squeegee angle α should be reduced and at the same time, the filling pressure should be increased, whereby the filling is completed even in a short fill time. However, since the conventional printing squeegee 101a performs two operations, namely, the filling operation to the solder paste 7 and the scraping operation from the surface 3a of the mask 3 as described above, the front end part 103 is deformed large if the filling pressure is increased, making it impossible to scrape the solder paste 7 from the surface 3a of the mask 3. The solder paste 7 is left at the surface 3a of the mask 3, as shown in Fig. 26. In the event that the front end part 103 of the squeegee 101a is further tightly pressed in touch with the surface 3a of the mask 3 so as to prevent the solder paste 7 from remaining at the surface 3a of the mask 3, as shown in Fig. 27, the solder paste 7 is actually scraped, whereas the amount of the deformation of the front end part 103 of the squeegee is increased due to the larger contact pressure. Therefore, when the front end part 103 reaches the opening 4, a part of the front end part 103 enters the opening 4 subsequent to the restoration of the front end part 103, undesirably scraping the solder paste 7 already filled in the opening 4. Moreover, the powder solder included in the solder paste 7 facilitates the scraping. The amount of the solder paste 7 filled in the opening 4 is hence decreased, obstructing stable printing.

Under the circumstances, when a printing is performed, conventionally, a worker sets, adjusts and changes printing conditions based on experiments in order to fully achieve both the scraping operation and the filling operation and print the solder paste stably. In other words, the printing conditions are set, adjusted and changed with a great personal difference and to maintain stable printing is a hard task as an issue.

SUMMARY OF THE INVENTION

The present invention is devised to solve the above-described inconveniences, and has for its object to provide a solder paste printing apparatus and a solder paste printing method whereby a solder paste can be printed stably even when a print time is increased as compared with the prior art.

In accomplishing these and other aspects, according to a first aspect of the present invention, there is provided a solder paste printing apparatus wherein a squeegee device moves in a printing direction to a surface of a mask having openings formed therein, thereby to print and apply solder paste on the surface via the openings to a face of a circuit board positioned at a rear face of the mask, said squeegee device comprising: a filling squeegee having a front end kept in a noncontact state via a gap to the surface at the time of printing, and filling the solder paste into the openings while moving in the printing direction; and a scraping squeegee arranged behind the filling squeegee in the printing direction, moving in the same direction as the filling squeegee while keeping touch with the surface at the time of printing thereby to remove unnecessary solder paste on the surface.

According to a second aspect of the present invention, there is provided a solder paste printing apparatus according to the first aspect, wherein the scraping squeegee is provided for each direction behind the filling squeegee with respect to the printing direction in a case where the squeegee reciprocates to the surface of the mask.

According to a third aspect of the present invention, there is provided a solder paste printing apparatus according to the second aspect, wherein the filling squeegee is divided to two in the printing direction.

According to a fourth aspect of the present invention, there is provided a solder paste printing apparatus according to any one of the first to third aspects, further comprising an angle setting device for setting the scraping squeegee so that an angle of the scraping squeegee in an axial direction thereof to the surface of the mask is an optional acute or obtuse angle.

According to a fifth aspect of the present invention, there is provided a solder paste printing apparatus according to the fourth aspect, wherein the scraping

squeegee is inclined with the obtuse angle by the angle setting device.

According to a sixth aspect of the present invention, there is provided a solder paste printing apparatus according to the fourth aspect, wherein the scraping squeegee is inclined with the acute angle by the angle setting device thereby to fill the solder paste into the openings as well as remove the unnecessary solder paste.

According to a seventh aspect of the present invention, there is provided a solder paste printing apparatus according to any one of the first to sixth aspects, wherein the scraping squeegee is disposed so that an extending direction of a line of contact between the scraping squeegee and the surface of the mask intersects with an extending direction of a side edge part defining one of the openings.

According to an eighth aspect of the present invention, there is provided a solder paste printing apparatus according to any one of the first to seventh aspects, wherein a face of the filling squeegee opposite to the surface of the mask forms a filling pressuring face which is inclined upward from the front end in the printing direction so as to press the solder paste to the surface and fill the solder paste to the openings.

According to a ninth aspect of the present invention, there is provided a solder paste printing apparatus according to the eighth aspect, further comprising a filling adjustment device for adjusting filling of the solder paste to the openings by varying at least one of a size of the gap and an intersection angle of the filling pressuring face and the surface.

According to a tenth aspect of the present invention, there is provided a solder paste printing apparatus according to the ninth aspect, further comprising a filling pressure detector for detecting a change of a filling pressure of the solder paste filled into the openings at the time of printing, and a control device for controlling the filling adjustment device based on the filling pressure detected by the filling pressure detector.

According to an eleventh aspect of the present invention, there is provided a solder paste printing apparatus according to the tenth aspect, wherein the filling pressure detector is a reaction force detector for detecting a reaction force which is a sum of the filling pressures of the solder paste acting to the whole filling pressuring face at the time of printing.

According to a twelfth aspect of the present invention, there is provided a solder paste printing apparatus according to the tenth aspect, wherein the filling pressure detector is a pressure detector set at the filling pressuring face for detecting the filling pressure of the solder paste directly.

According to a thirteenth aspect of the present invention, there is provided a solder paste printing method comprising: moving a filling squeegee in a printing direction at time of printing while keeping a front end of the filling squeegee in a noncontact state via a gap to a surface of a mask having openings formed therein, thereby filling a solder paste on the surface to the openings; and removing unnecessary solder paste on the surface by a scraping squeegee moving in touch with the surface in the printing direction.

According to a fourteenth aspect of the present invention, there is provided a solder paste printing method according to the thirteenth aspect, wherein the scraping squeegee is set so that an angle of the scraping squeegee in an axial direction thereof to the surface of the mask is an optional acute or obtuse angle.

According to a fifteenth aspect of the present invention, there is provided a solder paste printing method according to the fourteenth aspect, wherein, when the scraping squeegee is set with the obtuse angle, the scraping squeegee removes the unnecessary solder paste without adversely influencing the solder paste filled in the openings.

According to a sixteenth aspect of the present invention, there is provided a solder paste printing method according to the fourteenth aspect, wherein, when the scraping squeegee is set with the acute angle, the scraping squeegee fills the solder paste to the openings as well as removes the unnecessary solder paste.

According to a seventeenth aspect of the present invention, there is provided a solder paste printing method according to any one of the thirteenth to sixteenth aspects, wherein the scraping squeegee is set so that an extending direction of a line of contact between the scraping squeegee and the surface of the mask intersects with an extending direction of a side edge part defining one of the openings.

According to an eighteenth aspect of the present invention, there is provided a solder paste printing method according to any one of the thirteenth to seventeenth aspects, wherein a face of the filling squeegee opposite to the surface of the mask forms a filling pressuring face which is inclined upward from the front end in the printing direction so as to press the solder paste to the surface and fill the solder paste to the openings.

According to a nineteenth aspect of the present invention, there is provided a solder paste printing method according to the tenth aspect, wherein a change of a filling pressure of the solder paste when the solder paste is filled by the filling squeegee to the openings at the time of printing is detected by a filling pressure detector, and at least one of an intersection angle of the filling pressuring face and the surface and a size of the gap is adjusted based on the detected filling pressure, thereby to change printing condition.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other aspects and features of the present invention will become clear from the following description taken in conjunction with the preferred embodiments thereof with reference to the accompanying drawings, in which:

Fig. 1 is a diagram showing the schematic structure of a solder paste printing apparatus according to one embodiment of the present invention;

Fig. 2 is a diagram of a front end part of a filling member of a filling squeegee of Fig. 1;

Fig. 3 is a diagram of a model for obtaining a filling pressure of solder paste by the filling member of the filling squeegee of Fig. 1;

Fig. 4 is a diagram of a pressure distribution obtained from the model of Fig. 3;

Fig. 5 is a diagram of the filling member of the filling squeegee of Fig. 1 in a different embodiment;

Fig. 6 is a diagram of the filling squeegee of Fig. 1 in a different embodiment;

Fig. 7 is a diagram of the filling member of the filling squeegee of Fig. 1 in a yet different embodiment;

Fig. 8 is a flow chart of the operation of the solder paste printing apparatus of Fig. 1;

Fig. 9 is a diagram of a modified example of the solder paste printing apparatus in Fig. 1;

Fig. 10 is a diagram of an arrangement relation between a line of contact of the scraping squeegee and mask, and the opening in the solder paste printing apparatus of Fig. 9;

Fig. 11 is a diagram of a state when the solder paste is scraped while a side face of the scraping squeegee is set at an obtuse angle to a surface of the mask in the solder paste printing apparatus of Fig. 9;

Fig. 12 is a diagram of a model explanatory of why the solder paste is scraped by the scraping squeegee of Fig. 11;

Fig. 13 is a diagram of a state when the solder paste is filled in the openings while the side face of the scraping squeegee is set at an acute angle to the surface of the mask in the solder paste printing apparatus of Fig. 9;

Fig. 14 is a diagram when the angle of the side face of the scraping squeegee to the surface of the mask is changed variously in the solder paste printing apparatus of Fig. 9;

Fig. 15 is a diagram when the angle of the side face of the scraping squeegee to the surface of the mask is changed variously in the solder paste printing apparatus of Fig. 9;

Fig. 16 is a diagram when the angle of the side face of the scraping squeegee to the surface of the mask is changed variously in the solder paste printing apparatus of Fig. 9;

Fig. 17 is a diagram of a further modification of the solder paste printing apparatus of Fig. 1;

Fig. 18 is a perspective view of a filling member of a filling squeegee in the solder paste printing apparatus of Fig. 17;

Fig. 19 is a sectional view of the filling member of Fig. 18;

Fig. 20 is a diagram showing the schematic structure of a conventional solder paste printing apparatus;

Fig. 21 is a diagram showing a state when printing is conducted with the use of a squeegee of Fig. 20;

Fig. 22 is a diagram of a state when the solder paste is filled in the openings by the squeegee of Fig. 20;

Fig. 23 is a diagram of a model for obtaining a filling pressure produced to the solder paste by the squeegee of Fig. 20;

Fig. 24 is a diagram of a distribution of a filling pressure generated in the solder paste by the squeegee of Fig. 20;

Fig. 25 is a diagram of a state when non-filled parts are brought about in the openings of the mask;

Fig. 26 is a diagram of a state where the solder paste is left on the surface of the mask when a front end part of the squeegee of Fig. 20 is deformed large;

Fig. 27 is a diagram of a state where the solder paste filled in the openings is scraped when the front end part of the squeegee of Fig. 20 is deformed large;

Fig. 28 is a diagram of a state when a reaction force detector is set to the printing squeegee in the conventional solder paste printing apparatus of Fig. 20; and

Fig. 29 is a diagram explanatory of how the reaction force detector of Fig. 28 cannot detect a reaction force of the solder paste.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Before the description of the present invention proceeds, it is to be noted that like parts are designated by like reference numerals throughout the accompanying drawings.

An apparatus and a method for printing a solder paste according to one embodiment of the present invention will be described with reference to the drawings. The printing method is carried out by the printing apparatus. Parts functioning the same or similarly are designated by the same reference numerals throughout the drawings, the description of which will be omitted here. In the specification, a solder paste is a paste-like solder obtained by mixing powder solder with a high viscosity flux. An up-down driving device 11 and an angle variable device 12 for a filling squeegee 10 which will be described later correspond to an embodiment fulfilling the function of the filling adjustment device. A reaction force detector 13 and pressure detectors 532a, 532b to be described later correspond to an embodiment achieving the function of the filling pressure detector.

Fig. 1 is a schematic diagram in the neighborhood of a squeegee in a solder paste printing apparatus 51 of the embodiment. The squeegee moves both in the right and in the left directions in the solder paste printing apparatus 51.

In addition to a scraping squeegee 14a for use in printing in the right direction and a scraping squeegee 14b for use in printing in the left direction, the solder paste printing apparatus 51 has a filling squeegee 10 arranged at a position between the squeegees 14a and 14b in a printing direction for filling a solder paste 7 to openings 4 of a mask 3.

Each of the scraping squeegees 14a, 14b scraping unnecessary solder paste 7 on the mask 3 at the time of printing is moved up and down between a standby position 18 and a scrape position 19 by an up-down driving device 15, 16 mounted to a bed plate 17 of a squeegee head constituting the printing apparatus 51. The bed plate 17 is moved in the left, right printing direction by a driving device 49 controlled by a control device 48. In Fig. 1 showing a state when the printing is conducted in the right direction, the scraping squeegee 14a is lowered to the scrape position 19, while the scraping squeegee 14b is raised at the standby position 18. When the scraping squeegee 14a, 14b is at the scrape position 19, a front end part 20 of each squeegee comes in touch with a surface 3a of the mask 3 so that a suitable pressure is impressed to the surface 3a. Although a side face 21 of the front end part 20 of each of the scrape squeegees 14a, 14b is indicated to extend orthogonally to the surface 3a in Fig. 1, the side face 21 of each of the squeegees 14a, 14b is inclined at the actual time of printing with an optional acute or obtuse angle to the surface 3a of the mask 3, for example, as shown in Figs. 11, 13, thereby scraping unnecessary solder paste 7 on the surface 3a. The unnecessary solder paste 7 on the surface 3a is a solder paste present swelling over the surface 3a and openings 4 at the surface 3a and openings 4 of the mask 3.

The driving device 49 and up-down driving devices 15, 16 are respectively connected to the control device 48 controlling operations of the solder paste printing apparatus 51.

The filling squeegee 10 schematically has a filling member 22 and a holding member 23 holding the filling member 22 and is coupled via the reaction force detector 13 to a driving shaft 11a of an up-down driving device 11 therefor mounted to the bed plate 17. The up-down driving device 11 is connected to the control device 48 and driven via the control device 48 based on output information from the reaction force detector 13 thereby to move the driving shaft 11a up and down as will be described in detail later.

In the embodiment, one filling squeegee 10 is provided for both, right and left printing directions. The filling member 22 is formed schematically in the shape of the bottom of a ship as shown in the figure. A face at a front end part of the filling member 22 opposing the surface 3a constitutes, as is illustrated in a detailed manner in Fig. 2, a filling pressuring face 25 inclined upward from a front end 24 of the filling member 22 to each printing direction. The filling member 22 can be formed of rubber, metal or the like material used in the conventional squeegees. On the occasion of printing, the filling squeegee 10 is arranged so that the front end 24 has a gap H2 of a size h2 to the surface 3a, and moreover, an intersecting part 26 between a side face 22a at the side of the printing direction of the filling member 22 and the filling pressuring face 25 assumes a gap H1 of a size h1 to the surface 3a.

Owing to the filling squeegee 10 with the above-described filling member 22 and the scraping squeegees 14a, 14b provided in the apparatus, a part 9 is never left without being filled with the solder paste 7 in the openings 4 of the mask 3 unlike the conventional apparatus even when a squeegee speed of the filling squeegee 10 is increased, and stable printing is achieved. The reason for this will be described below.

The filling pressure generated when the solder paste 7 is filled in the openings 4 by the filling squeegee 10 will be depicted with reference to Fig. 2. In the state shown in Fig. 2, when the filling squeegee 10 is moved right as indicated by an arrow, the solder paste 7 enters from the side of the gap H1 to the filling pressuring face 25 of the filling member 22 and flows out of the gap H2. This phenomenon can be explained by an example of a flow of a substance entering a narrow wedge-like gap, and concretely, a model shown in Fig. 3 is used here to depict the phenomenon. The model is a generally known one used in the description of fluid lubrication at a bearing or the like and is approximate to the filling member 22 of the right half from the gap H2 to the gap H1. In Fig. 3, supposing that a size of a gap at the entrance side of a fluid between a wall body 301 and a reference face 302 is h_1, a size of the gap at the exit side is h_2, a distance between the entrance and exit gaps is L, a size of a gap between the wall body 301 and reference face 302 at a distance x from the entrance gap is h, a speed of the moving wall body 301 is v, and a viscosity of the fluid is η, a pressure p' generated because of a flow of the fluid at the distance x is expressed by the following equation. A distribution of the pressure p' is as shown in Fig. 4, as is well known.

$$p'=(6\eta vL/(h_1^{\ 2}-h_2^{\ 2}))*((h_1-h)(h-h_2)/h^2) \qquad (2)$$

The filling pressure and a pressure distribution generated to the solder paste 7 by the filling member 22 of the filling squeegee 10 can be considered in the same way. In comparing a shaded part 303 in Fig. 4 with the shaded part 105 in Fig. 24, it is clear that the filling pressure is generated high in a wide range with the employment of the filling squeegee 10. Accordingly, the solder paste is perfectly filled into the openings 4 even if the fill time is short. A filling defect or failure such as the non-filled part, etc. is never brought about even at an increased squeegee speed, thus accomplishing stable printing.

The above-described filling member 22 is held by the holding member 23 in a manner to be able to swing both in the right and in the left printing directions at a pin

27 coaxial with the driving shaft 11a. As will be described later, the holding member 23 is provided with the angle variable device 12 such as a motor or a cylinder so as to make variable an intersection angle of the filling pressuring face 25 of the filling member 22 and the surface 3a of the mask 3 and maintain the filling member 22 which can swing centering the pin 27, properly at the intersection angle. One end of a main body of the angle variable device 12 is supported rotatably by the holding member 23 and a front end part of a driving shaft 12a which can move forward and backward to the main body is rotatably coupled to a shoulder part 22a of the filling member 22. Therefore, the filling member 22 swings at a fulcrum of the pin 27 when the driving shaft 12a is moved forward and backward. The angle variable device 12 is also connected to the control device 48, changing the intersection angle by advancing or retreating the driving shaft 12a under the control of the control device 48.

According to the present embodiment, the holding member 23 is connected to the driving shaft 11a of the up-down driving device 11 via the reaction force detector 13 such as a load cell so as to detect a reaction force acting to the filling pressuring face 25 of the filling member 22 via the solder paste 7 at the time of printing. The reaction force cannot be detected simply by providing the conventional solder paste printing apparatus with the reaction force detector 13. The reason will be discussed with reference to Fig. 28. The front end part of the conventional printing squeegee 101a moves while keeping touch with the surface 3a of the mask 3, and consequently is deformed large due to a friction, as shown in Fig. 29. What's worse, a contact point between the front end part of the squeegee 101a and the surface 3a of the mask 3 is not present on a vertical direction of the reaction force detector. When the contact point of the squeegee 101a is pressed up by the reaction force of the solder paste 7, an end part of the squeegee 101a at the side opposite to the contact point is pulled towards the mask 3. The reaction force detector virtually detects this tensile force to the mask 3 in spite of the reaction force by the solder paste 7 acting to the squeegee 101a. The reaction force detector hence cannot detect the reaction force of the solder paste 7. In contrast, the filling squeegee 10 of the printing apparatus 51 of the embodiment moves without touch with the surface 3a of the mask 3, whereby the reaction force of the solder paste 7 can be detected.

As is clear from Fig. 3 and expression (2), the reaction force acting to the filling pressuring face 25 can be obtained by integrating the pressure p' in a range of x=0-L . A state of the filling pressure can be known from the reaction force of the solder paste 7 detected by the reaction force detector 13. Moreover, the pressure p' can be changed by adjusting the sizes h1 and h2 of the gaps H1 and H2, as is understood from the expression (2), and the sizes h1 and h2 can be adjusted by driving at least either of the up-down driving device 11 and angle variable device 12 of the squeegee 10.

For the above purpose, the reaction force detector 13 is connected to the control device 48. The control device 48 controls the drive of the up-down driving device 11 based on information of the reaction force detected by the reaction force detector 13 thereby to move the filling member 22 up/down via the driving shaft 11a so as to adjust the size h2 of the gap H2 or the size h1 of the gap H1 to prevent the non-filled part 9 from being formed in the openings 4 of the mask 3, or the drive of the angle variable device 12 to adjust the intersection angle. For example, even if physical properties of the solder paste 7, particularly the viscosity η is changed due to an environmental change or the like influence and the filling pressure is changed or, the kind of the, solder paste 7 is changed when the type of products is to be switched, etc., the control device 48 operates at least one of the up-down driving device 11 and angle variable device 12 so that the information of the reaction force of the solder paste 7 detected by the detector 13 is approximated to a preset reaction force value or a reaction force value before the type is switched. In this manner, at least one of a height of the filling squeegee 10 and the intersection angle is changed and the sizes h1 and h2 are adjusted, in other words, printing conditions are automatically adjusted and changed, achieving stable printing. The controlling to the up-down driving device 11 and angle variable device 12 by the control device 48 may be carried out in real time along with the movement of the filling squeegee 10 or for every circuit board or at every time of printing.

The printing conditions are thus automatically adjusted and changed, maintaining stable printing and shortening a work time.

Although the filling pressuring face 25 of the filling member 22 of the filling squeegee 10 is flat in the embodiment, the face 25 is not limited to this, but may be a curved face projecting to the surface 3a as exemplified in Fig. 5. In other words, a shape of the filling pressuring face 25 is not specified so long as the size h1 of the gap between the filling pressuring face 25 and the surface 3a of the mask 3 is larger than the size h2 with respect to the printing direction, i.e., h1>h2 is satisfied. At the same time, the front end 24 of the filling member 22 may be sharp as in Fig. 2 or flat parallel to the surface 3a over a suitable length in the printing direction as shown in Fig. 7.

The reaction force detector 13 and angle variable device 12 can be set at any positions so long as respective functions are fulfilled, not restricted to the above-described positions.

Since the printing apparatus 51 is a type moving both in the right and left directions, the printing apparatus is equipped with two scraping squeegees 14a, 14b. The printing apparatus may be a type moving in either direction only, and in that case, the scraping squeegee 14a or 14b corresponding to the moving direction is pro-

vided.

In the present printing apparatus 51, the filling member 22 of the filling squeegee 10 is formed to be symmetric right and left and the same filling squeegee 10 is used for both printing directions. However, as shown in Fig. 6, the filling squeegee may be divided to a right filling squeegee 305a and a left filling squeegee 305b to operate and print individually. To install two filling squeegees 305a, 305b has the following merit. In the case of the single filling squeegee 10, when the height or the intersection angle of the squeegee 10 is not controlled in real time, but is set before the printing is started, and if the height or intersection angle of the squeegee 10 is changed during printing in the right direction, the up-down driving device 11 or angle variable device 12 should be operated before the start of the left printing in order to obtain the same printing conditions in the left printing as well. To contrary, when two filling squeegees 305a, 305b are provided, the up-down driving devices 11 and angle variable devices 12 can be driven separately beforehand in accordance with the printing directions.

The operation when the solder paste is printed with the use of the above-constituted printing apparatus 51 will be described with reference to Fig. 8. The up-down driving device(s) 11 and angle variable device(s) 12 are controlled in real time in the description hereinbelow.

The following operations are carried out in step 1 (indicated by "S1" in Fig. 8). A predetermined amount of the solder paste 7 is supplied to the surface 3a of the mask 3. When the printing is performed in the right direction, the printed board 5 is positioned and overlapped with the mask 3 and the filling squeegee 10 and right scraping squeegee 14a are descended respectively by the up-down driving devices 11 and 15. At this time, the front end part 20 of the scraping squeegee 14a is brought in touch with the surface 3a of the mask 3 with a suitable pressing force. The filling squeegee 10 is, as shown in Fig. 2, not in touch with the surface 3a of the mask 3, securing the gap H2 of the predetermined size h2. The squeegee 10 is moved down so that the gap H2 is located behind the supplied solder paste 7 in the printing direction.

In step 2, while the state is maintained, the bed plate 17 is moved right by the driving device 49 and the filling squeegee 10 and scraping squeegee 14a are moved linearly in the right printing direction. The filling of the solder paste 7 to the openings 4 of the mask 3 by the filling squeegee 10 is thus started.

The reaction force acting to the filling squeegee 10 is detected by the reaction force detector 13 in step 3. Whether or not the detected reaction force is, for example, within the preset reaction force value as described before is judged in step 4. When the detected reaction force is outside a proper range, the control device 48 drives at least one of the up-down driving device 11 and angle variable device 12 to bring the detected reaction force within the proper range in step 5. At least one of the height and the intersection angle of the filling squeegee 10 is changed accordingly.

In step 6, a layer of the solder paste 7 formed on the surface 3a of the mask 3 because of the gap H2 of the filling squeegee 10 is scraped by the scraping squeegee 14a. Through the scraping by the scraping squeegee 14a, the unnecessary solder paste 7 on the surface 3a of the mask 3 is removed, so that the solder paste 7 filled in the openings 4 to swell over the surface 3a is turned to be even with the surface 3a.

Thereafter, the printed board 5 is separated from the mask 3 to print the solder paste 7. In the left printing similar to the right printing, after the printed board 5 is positioned and overlapped with the mask 3, the filling squeegee 10 and the left scraping squeegee 14b are lowered by the up-down driving devices 11 and 16. In this case also, the front end part 20 of the scraping squeegee 14b are brought in touch with the surface 3a of the mask 3 with a suitable pressing force, while the filling squeegee 10 is not in direct touch with the surface 3a of the mask 3 with maintaining the gap H2 of the predetermined size h2. The filling squeegee 10 is lowered so that the gap H2 is positioned behind the solder paste 7 in the printing direction leftward. The subsequent operations are carried out in the same manner as in the right printing.

The above-described printing operations are repeated alternately, whereby the solder paste 7 is continuously printed and applied on lands 6 of the printed board 5 via the mask 3.

According to the present embodiment, the side face 21 of the scraping squeegee 14a, 14b is inclined with an optional acute or obtuse angle to the surface 3a of the mask 3 at the time of actual printing thereby to scrape unnecessary solder paste 7. However, the scraping squeegee 14a, 14b may be inclined beforehand axially to the surface 3a of the mask 3, concretely, so that the side face 21 of the squeegee 14a, 14b may be inclined beforehand with an optional acute or obtuse angle, as will be described hereinbelow.

More specifically, in a solder paste printing apparatus 501 shown in Fig. 9, the scraping squeegees 14a, 14b are held by holders 507, 510 which are set to holding members 506, 509 fitted to driving shafts 15a, 16a of the up-down driving devices 15, 16 via pins 505, 508. The pins 505, 508 are arranged coaxially with the driving shafts 15a, 16a, supporting the holders 507, 510 so that the holders 507, 510 can swing in the left and right printing directions to the holding members 506, 509. In consequence, the side face 21 of each scraping squeegee 14a, 14b can be set to the surface 3a of the mask 3 with an optional angle in a range from an acute angle to right angles to an obtuse angle. The pins 505, 508 are, for instance, constituted of clamping members such as bolts and nuts. The holders 507, 510 are stopped to swing and the squeegees 14a, 14b are fixed at the optional angle by clamping of the pins 505, 508.

The holders 507, 510 may be adapted to swing

centering the pins 505, 508 by a known mechanism using, e.g., a motor or the like thereby to be fixed at the optional angle.

As described hereinabove, the pins 505, 508, holding members 506, 509 and holders 507, 510 constitute angle setting devices 502, 503 for the scraping squeegees 14a, 14b.

The solder paste printing apparatus 501 of Fig. 9 is in the same constitution except the above points as the printing apparatus 51 described with reference to Fig. 1.

In the case where the side face 21 of the scraping squeegee 14a, 14b is set, for example, at an obtuse angle to the surface 3a of the mask 3, as indicated in Fig. 11, the unnecessary solder paste 7 on the surface 3a can be removed without influencing to the utmost the solder paste 7 filled in the openings 4 of the mask 3 by the filling squeegee 10. The reason will be made clear with reference to Fig. 12 showing a general shearing model of cutting a structure 521 by a tool 520. When the structure 521 is cut by the tool 520 as shown as the above model, a shear force by the tool 520 acts mainly to an upper part than a finish face 522, namely, a shaded shear area 524 in Fig. 12. That is, the shear force acts only to a portion which becomes a chip part 523. Therefore, in Fig. 12, if the tool 520 is replaced with the scraping squeegee 14a, 14b, the work 521 lower than the finish face 522 with the solder paste 7 filled in the openings 4, and the chip part 523 with the unnecessary solder paste 7 on the surface 3a, the shear force acts solely to the unnecessary solder paste 7 on the surface 3a when the side face 21 of the scraping squeegee is set at an obtuse angle, and accordingly the unnecessary solder paste 7 on the surface 3a can be removed without affecting the solder paste 7 filled in the openings 4.

On the other hand, when the side face 21 of the scraping squeegee 14a, 14b is set to be an acute angle to the surface 3a of the mask 3, the following effect is obtained. For instance, even when the solder paste 7 is filled insufficiently by the filling squeegee 10 to the openings 4 thereby forming the non-filled parts 9, the solder paste 7 can be surely filled in the openings 4 by the scraping squeegee 14a, 14b with the acute angle. That is, when the scraping squeegee 14a, 14b is set with the acute angle as in Fig. 13, not only the filling squeegee 10, but the scraping squeegee 14a, 14b supplementarily produces the filling pressure. Therefore, the scraping squeegee 14a, 14b can be effective to refill the solder paste 7 to the openings 4 where the non-filled parts 9 are present and at the same time, remove the unnecessary solder paste 7 on the surface 3a.

As shown in Figs. 14-16, the same effect as described above can be attained also when the side face 21 is set with an obtuse angle or right angles to the surface 3a. That is, when, depending on the configuration of the front end part 20 of each of the squeegee 14a, 14b, an angle of the face 21a which is arranged beforehand in the printing direction and is separated from the side face 21 is acute to the surface 3a as compared with the front end part 20 of the scraping squeegee 14b being brought in touch with the surface 3a, even though an angle of the side face 21 is set to be obtuse or right angle, the effect similar to that in a case where the angle is acute can be obtained. The solder paste 7 is filled to the openings 4 mainly by the filling squeegee 10, while the scraping squeegee 14a, 14b assists the filling. Therefore, it is enough that the filling pressure generated by the scraping squeegee 14a, 14b is smaller than that of the filling squeegee 10, thereby allowing the side face 21 of the squeegee 14a, 14b to be set with a large angle, without inviting the issue as when the squeegee angle α is reduced in the conventional squeegee. The non-filled part 9 can be prevented even when the squeegee speed is enhanced, and stable printing can be achieved.

Further, as indicated in a schematic view of an upper face of the mask in Fig. 10, the scraping squeegee 14a, 14b is preferably arranged so that a line of contact 515 between the front end part 20 of the squeegee and the surface 3a of the mask 3 is not parallel to an extending direction of a side edge part defining the opening 4 in the mask 3. The openings 4 of the mask 3 are sometimes formed in a pattern so that the extending direction of the side edge part defining the opening 4 is linear and a straight part 4a is formed having its extending direction orthogonal to a printing direction shown by an arrow. In this state, if the scraping squeegee 14a, 14b is moved in the printing direction while an extending direction of the line of contact 515 is orthogonal to the printing direction, namely, the extending direction of the line of contact 515 is in parallel to the extending direction of the straight part 4a, the front end part 20 of the scraping squeegee 14a, 14b is caught by the straight part 4a of the opening 4 of the mask 3, whereby the front end part 20 or opening 4 is possibly broken. Therefore, the scraping squeegee 14a, 14b is preferably fitted to the driving shaft 15a, 16b of the up-down driving device 15, 16 so that an angle 516 of the extending direction of the line of contact 515 to the extending direction of the straight part 4a is acute or an angle 517 is obtuse to let the extending direction of the line of contact 515 intersect with the extending direction of the side edge part defining the opening 4. The above angle 516 is preferably approximately 1 to 45°, most preferably 45°.

The scraping squeegee 14a, 14b may be fitted to the driving shaft 15a, 16b in a manner to make the angle 516, 517 changeable.

In the foregoing embodiment, the scraping squeegee 14a, 14b is orientated to the mask 3 so that the openings 4 of the mask 3 are not parallel to the extending direction of the line of contact 515. Opposite to the above, the mask 3 may be shifted to the scraping squeegee 14a, 14b so as to make the straight part 4a not parallel to the line of contact 515 with the extending direction of the line of contact 515 kept orthogonal to the

printing direction.

In the event that the openings 4 of the mask 3 are formed in pattern not to have the straight parts 4a parallel to the extending direction of the line of contact 515, it is unnecessary to orient the scraping squeegee 14a, 14b, for example, to assume the acute angle 516.

In the embodiment as above, the reaction force detector 13 is set to the driving shaft 11a of the up-down driving device 11 for the filling squeegee 10 to detect the reaction force of the solder paste 7 acting to the whole face of the filling squeegee 10. However, the filling pressure by the solder paste 7 to the opening 4 can be detected directly in a constitution as will be described below.

In a solder paste printing apparatus 535 shown in Fig. 17, a filling squeegee 530 corresponding to the above filling squeegee 10 generally includes, similar to the filling squeegee 10, a filling member 531 corresponding to the filling member 22 and a holding member 23 holding the filling member 531, and is coupled to the driving shaft 11a of the up-down driving device 11, for the filling squeegee 530, mounted to the bed plate 17. The up-down driving device 11 is connected to a control device 536 and is driven via the control device 536, as will be detailed later, based on information of outputs of a pressure detector 532a or 532b such as a pressure detecting sensor thereby to raise or lower the driving shaft 11a.

As shown in Figs. 18 and 19, the pressure detector 532a, 532b is built in the filling member 531 in the vicinity of approximately the center in an axial direction of the filling member 531 and at a front end part 534 of the filling member 531 inside a filling pressuring face 533. The pressure detector 532a, 532b is set at a position where the solder paste 7 is present at the time of printing so as to detect the filling pressure generated when the solder paste 7 is filled in the openings 4 by the filling squeegee 530. At least one detector is provided for each filling pressuring face 533. As described earlier, the filling pressure shows a maximum value in the distribution in the vicinity of the front end 534 of the filling member 531, and therefore the pressure detector 532a, 532b is preferably set in the vicinity of the front end 534 of the filling member 531. Moreover, in order to more correctly detect the filling pressure, the pressure detector 532a, 532b is built in the filling member 531 so as to have its pressure detection face exposed to the filling pressuring face 533 as illustrated in the drawings.

The other structure of the solder paste printing apparatus 535 in Fig. 17 is equal to those of the solder paste printing apparatuses 51, 501 shown in Figs. 1 and 9, except the above points.

A difference of the reaction force detector 13 of the printing apparatus 51 and the pressure detectors 532a, 532b of the printing apparatus 535 in the above embodiments will now be described. Although both detectors are installed to detect a state change of the filling pressure of the solder paste 7 at the time of printing, the pressure detector 532a, 532b directly detects the filling pressure, whereas the reaction force detector 13 detects the reaction force which is a sum of the filling pressures acting to the whole face of the filling pressuring face 25, in other words, detects the filling pressure indirectly.

Even when the filling pressure is the same, the reaction force detector 13 detects the reaction force different in accordance with an area of the filling pressuring face 25. For example, if a size of the filling member 22 is changed to fit the printed board 5, it takes a lot of labor to refer to the previously accumulated information of reaction forces, thus causing to reproduce printing conditions. Needless to say, it is easy to refer to the previously accumulated information unless the area of the filling pressuring face 25 is changed when the same filling member 22 is used. On the other hand, since the filling pressure is detected directly with the use of the pressure detector 532a, 532b, the previously detected information of pressures can be readily referred to even if the filling member 531 is changed in size, whereby printing conditions can be reproduced easily, which is preferable.

The thus-constituted printing apparatus 535 operates in the same manner to print the solder paste as the printing apparatus 51 of the above embodiment. Fundamentally, the "reaction force" in steps 3, 4 in Fig. 8 is replaced with the "pressure". More specifically, the filling pressure generated when the solder paste 7 is filled in the openings 4 by the filling squeegee 530 is detected by the pressure detector 532a in step 3, and whether or not the detected pressure is, for instance, within a preliminarily set value range is judged in step 4. If the detected pressure is outside the proper range, in step 5, the control device 536 drives at least one of the up-down driving device 11 and angle variable device 12 so as to set the detected pressure in the proper range. In consequence, at least one of the height and intersection angle of the filling squeegee 530 is changed.

The other operations than the above are the same as in the printing apparatus 51. The solder paste 7 is continuously printed and applied onto lands 6 of the printed board 5 via the mask 3 through the alternate repetition of the above operations.

In the foregoing description, only one of the reaction force detector 13 and the pressure detectors 532a, 532b is arranged in the apparatus. However, both of the detectors may be set in the printing apparatus to detect both the reaction force and the filling pressure.

According to the solder paste printing apparatus according to the first aspect of the present invention and the solder paste printing method according to the second aspect of the present invention, as is fully described above, the filling squeegee and scraping squeegees are provided. The filling squeegee is moved in a state without contact with the surface of the mask thereby to fill the solder paste in openings of the mask, then the unnecessary solder paste on the mask is removed by

the scraping squeegee. Accordingly, the solder paste is prevented from being filled in the openings defectively or scraped improperly even when the squeegee speed is increased, so that the solder paste can be printed stably on the circuit board. The print time can be reduced, thereby improving productivity.

The entire disclosure of Japanese Patent Applications No. 8-329758 filed on December 10, 1996 and No. 9-134778 filed on May 26, 1997, including specification, claims, drawings, and summary are incorporated herein by reference in its entirety.

Although the present invention has been fully described in connection with the preferred embodiments thereof with reference to the accompanying drawings, it is to be noted that various changes and modifications are apparent to those skilled in the art. Such changes and modifications are to be understood as included within the scope of the present invention as defined by the appended claims unless they depart therefrom.

Claims

1. A solder paste printing apparatus wherein a squeegee device moves in a printing direction to a surface (3a) of a mask (3) having openings farmed therein, thereby to print and apply solder paste (7) on the surface via the openings to a face of a circuit board positioned at a rear face of the mask,
said squeegee device comprising:

a filling squeegee (10) having a front and (24) kept in a noncontact state via a gap (H2) to the surface at the time of printing, and filling the solder paste into the openings while moving in the printing direction; and
a scraping squeegee (14) arranged behind the filling squeegee in the printing direction, moving in the same direction as the filling squeegee while keeping touch with the surface at the time of printing thereby to remove unnecessary solder paste on the surface.

2. A solder paste printing apparatus according to claim 1, wherein the scraping squeegee is provided for each direction behind the filling squeegee with respect to the printing direction in a case where the squeegee reciprocates to the surface of the mask.

3. A solder paste printing apparatus according to claim 2, wherein the filling squeegee is divided to two in the printing direction.

4. A solder paste printing apparatus according to any one of claims 1-3, further comprising an angle setting device (502, 503) for setting the scraping squeegee so that an angle of the scraping squeegee in an axial direction thereof to the surface of the mask is an optional acute or obtuse angle.

5. A solder paste printing apparatus according to claim 4, wherein the scraping squeegee is inclined with the obtuse angle by the angle setting device.

6. A solder paste printing apparatus according to claim 4, wherein the scraping squeegee is inclined with the acute angle by the angle setting device thereby to fill the solder paste into the openings as well as remove the unnecessary solder paste.

7. A solder paste printing apparatus according to any one of claims 1-6, wherein the scraping squeegee is disposed so that an extending direction of a line of contact between the scraping squeegee and the surface of the mask intersects with an extending direction of a side edge part defining one of the openings.

8. A solder paste printing apparatus according to any one of claims 1-7, wherein a face of the filling squeegee opposite to the surface of the mask forms a filling pressuring face (25) which is inclined upward from the front end in the printing direction so as to press the solder paste to the surface and fill the solder paste to the openings.

9. A solder paste printing apparatus according to claim 8, further comprising a filling adjustment device (11, 12) for adjusting filling of the solder paste to the openings by varying at least one of a size of the gap and an intersection angle of the filling pressuring face and the surface.

10. A solder paste printing apparatus according to claim 9, further comprising a filling pressure detector (13, 532a, 532b) for detecting a change of a filling pressure of the solder paste filled into the openings at the time of printing, and a control device (48) for controlling the filling adjustment device based on the filling pressure detected by the filling pressure detector.

11. A solder paste printing apparatus according to claim 10, wherein the filling pressure detector is a reaction force detector (13) for detecting a reaction force which is a sum of the filling pressures of the solder paste acting to the whole filling pressuring face at the time of printing.

12. A solder paste printing apparatus according to claim 10, wherein the filling pressure detector is a pressure detector (532a, 532b) set at the filling pressuring face for detecting the filling pressure of the solder paste directly.

13. A solder paste printing method comprising:

moving a filling squeegee (10) in a printing direction at time of printing while keeping a front end of the filling squeegee in a noncontact state via a gap (H2) to a surface (3a) of a mask (3) having openings formed therein, thereby filling a solder paste (7) on the surface to the openings; and

removing unnecessary solder paste on the surface by a scraping squeegee (14) moving in touch with the surface in the printing direction.

14. A solder paste printing method according to claim 13, wherein the scraping squeegee is set so that an angle of the scraping squeegee in an axial direction thereof to the surface of the mask is an optional acute or obtuse angle.

15. A solder paste printing method according to claim 14, wherein, when the scraping squeegee is set with the obtuse angle, the scraping squeegee removes the unnecessary solder paste without adversely influencing the solder paste filled in the openings.

16. A solder paste printing method according to claim 14, wherein, when the scraping squeegee is set with the acute angle, the scraping squeegee fills the solder paste to the openings as well as removes the unnecessary solder paste.

17. A solder paste printing method according to any one of claims 13-16, wherein the scraping squeegee is set so that an extending direction of a line of contact between the scraping squeegee and the surface of the mask intersects with an extending direction of a side edge part defining one of the openings.

18. A solder paste printing method according to any one of claims 13-17, wherein a face of the filling squeegee opposite to the surface of the mask forms a filling pressuring face (25) which is inclined upward from the front end in the printing direction so as to press the solder paste to the surface and fill the solder paste to the openings.

19. A solder paste printing method according to claim 18, wherein a change of a filling pressure of the solder paste when the solder paste is filled by the filling squeegee to the openings at the time of printing is detected by a filling pressure detector (13, 532a, 532b), and at least one of an intersection angle of the filling pressuring face and the surface and a size of the gap is adjusted based on the detected filling pressure, thereby to change printing condition.

Fig. 1

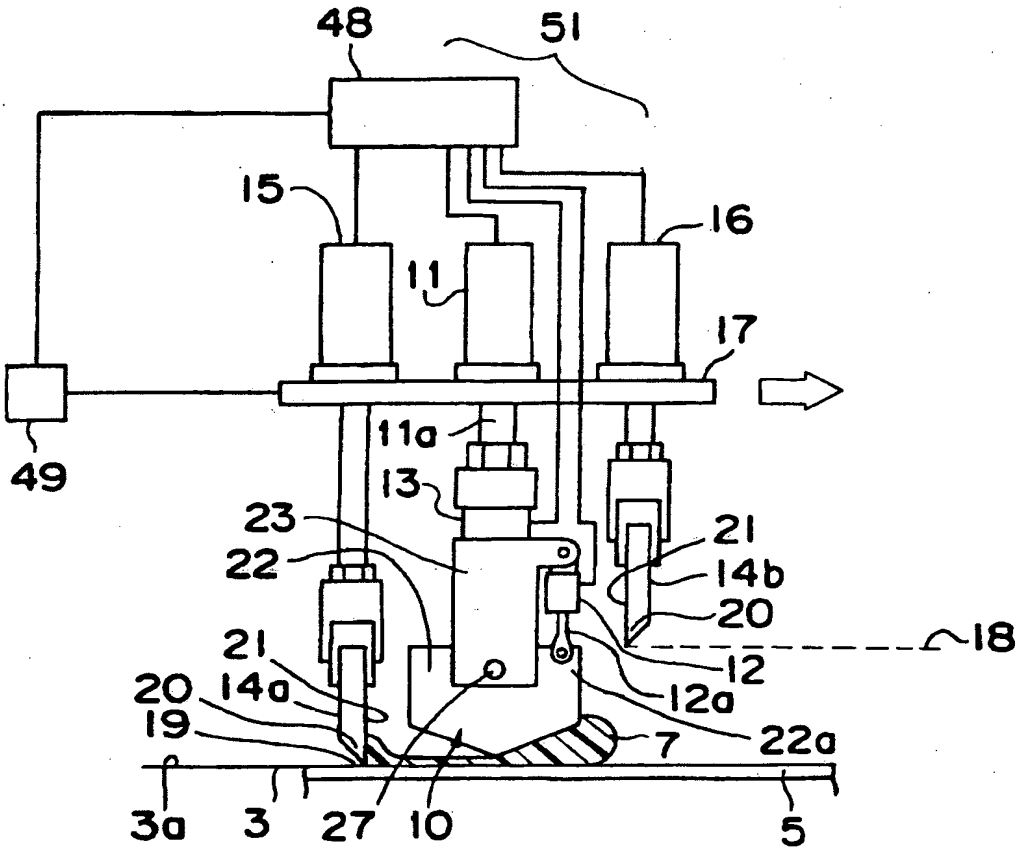


Fig. 2

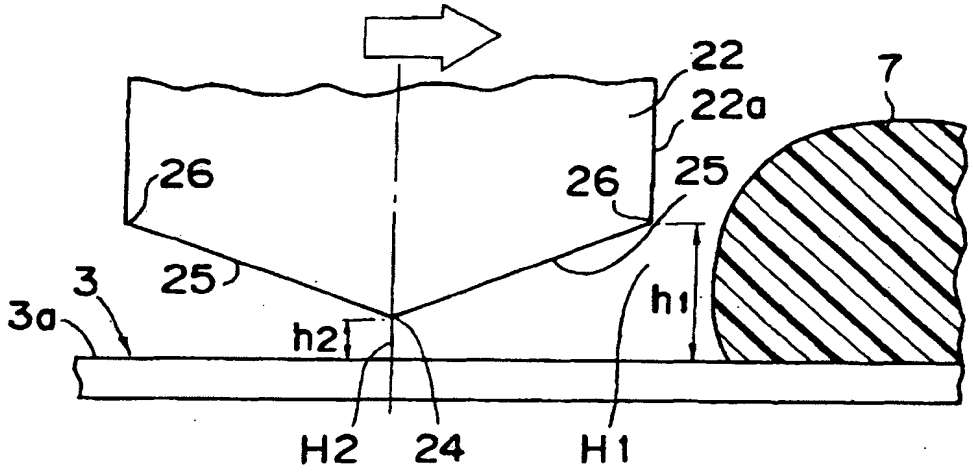


Fig. 3

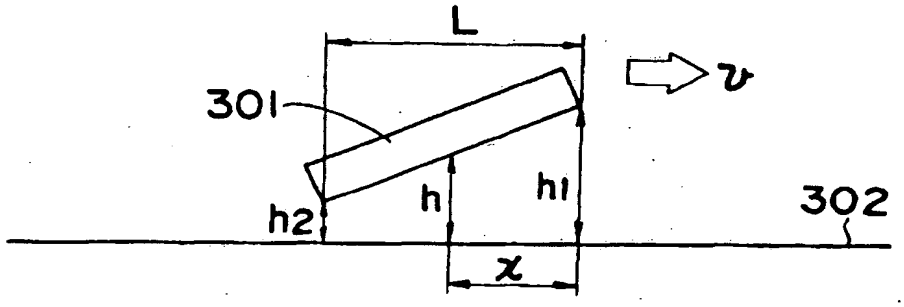


Fig. 4

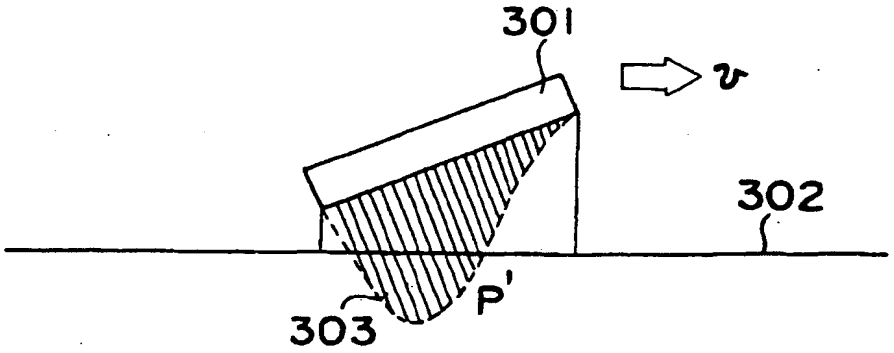


Fig. 5

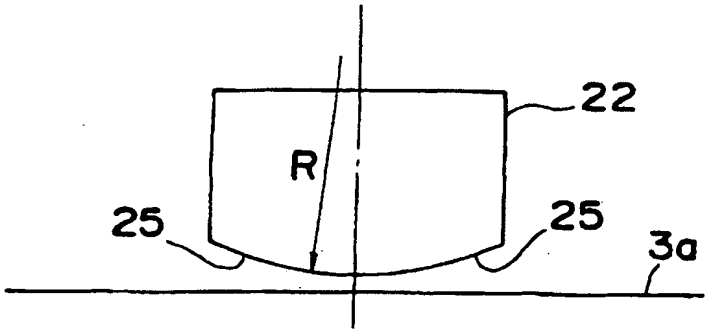


Fig. 6

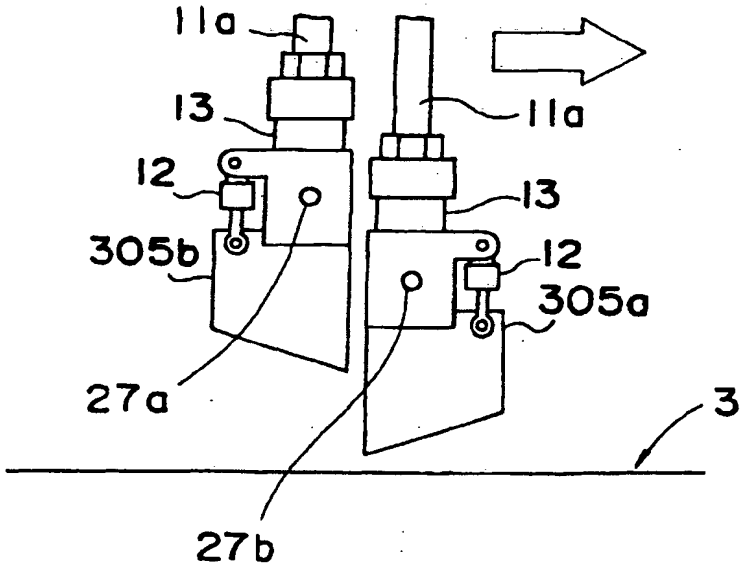


Fig.7

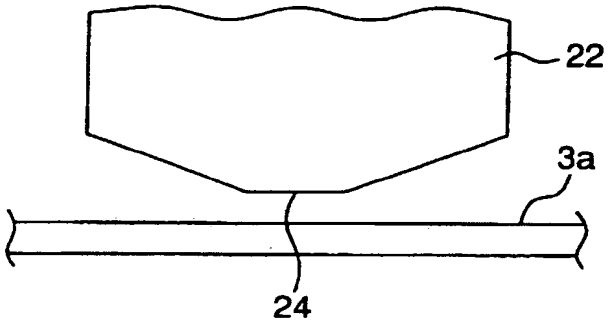


Fig. 8

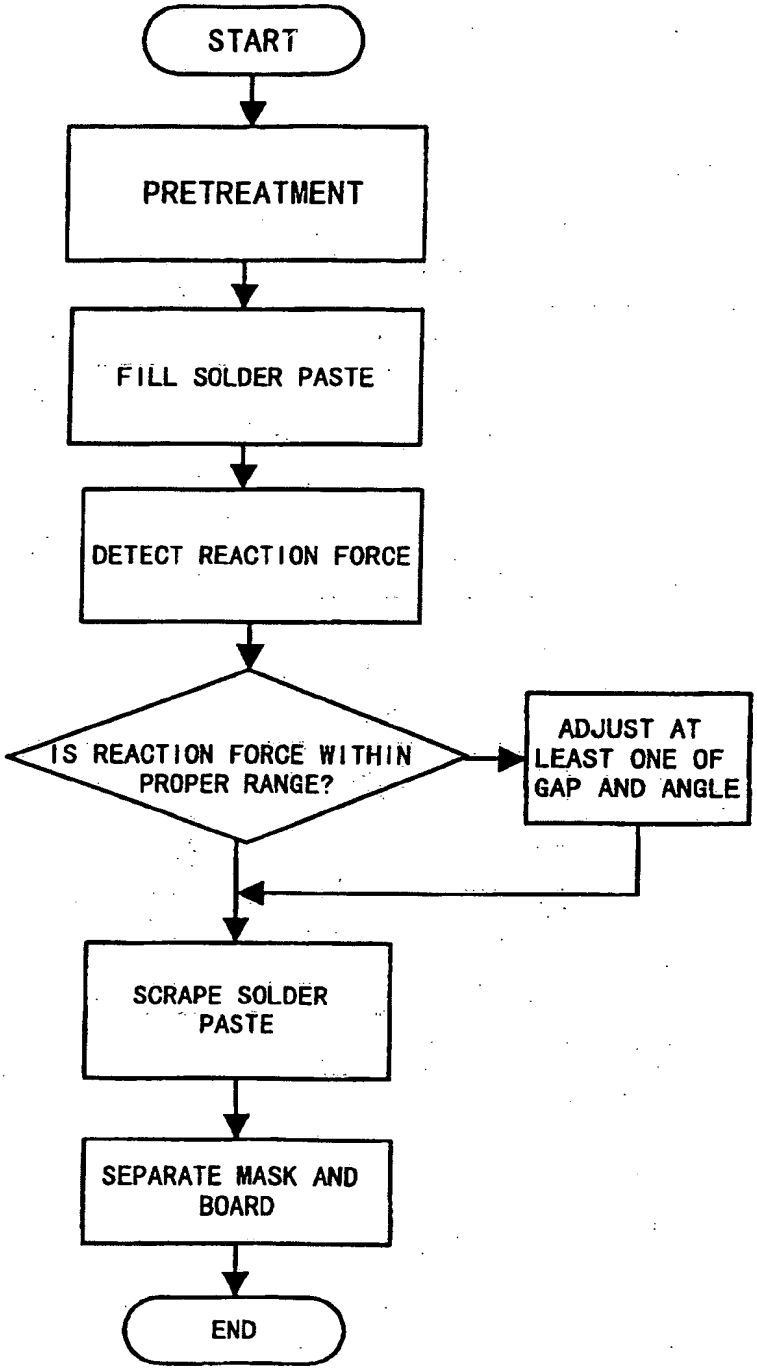


Fig. 9

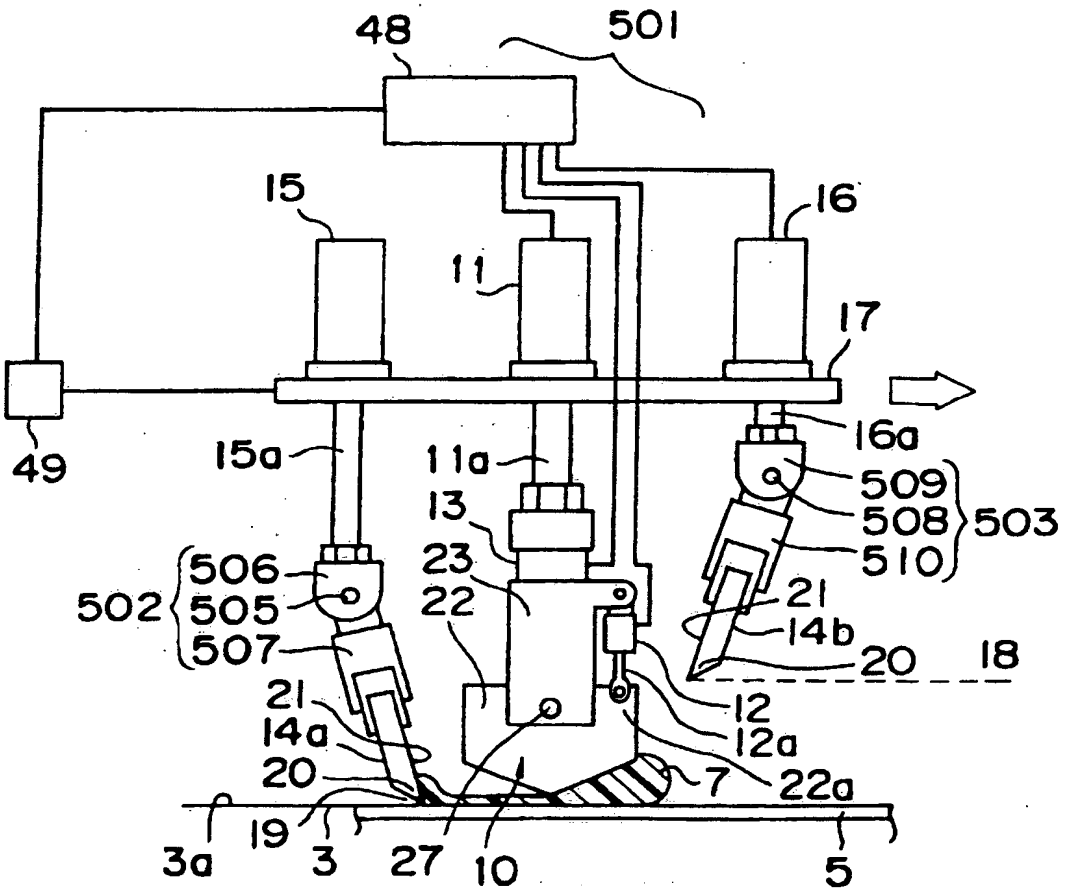


Fig. 10

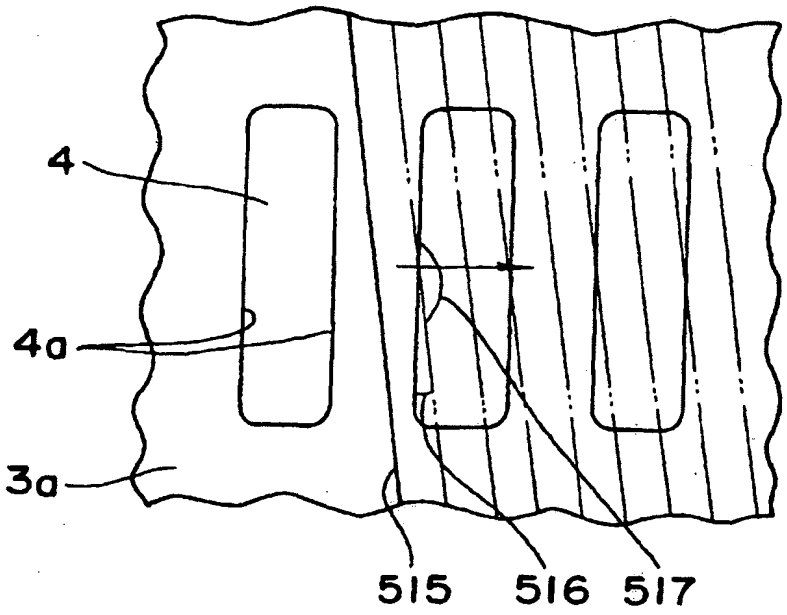


Fig. 11

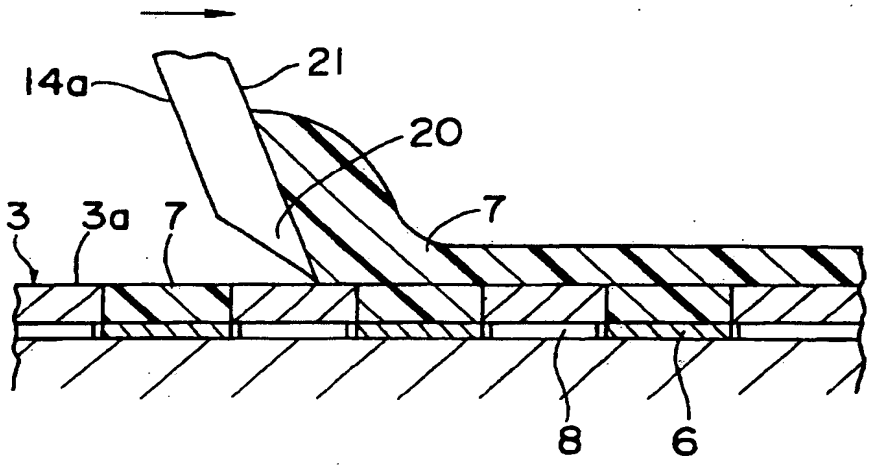


Fig. 12

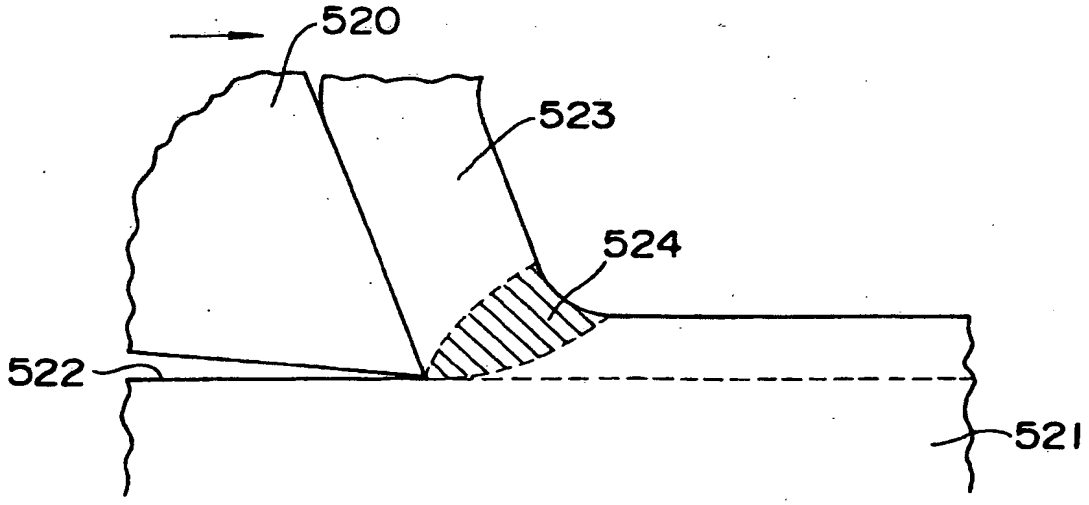


Fig. 13

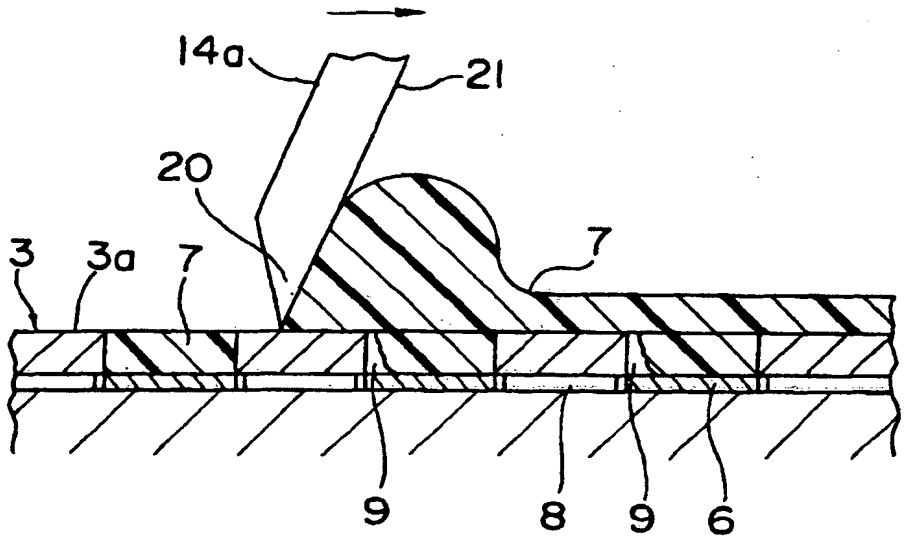


Fig. 14

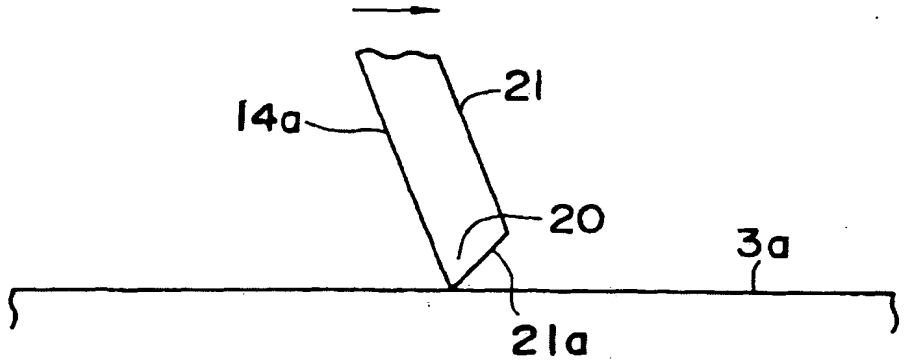


Fig. 15

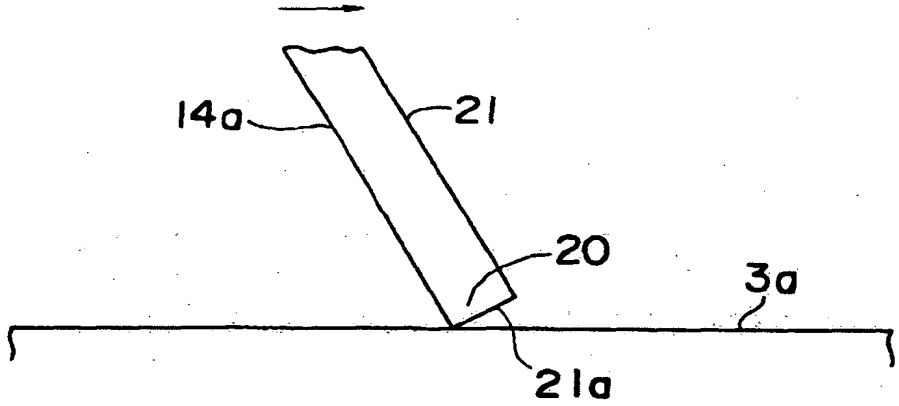


Fig. 16

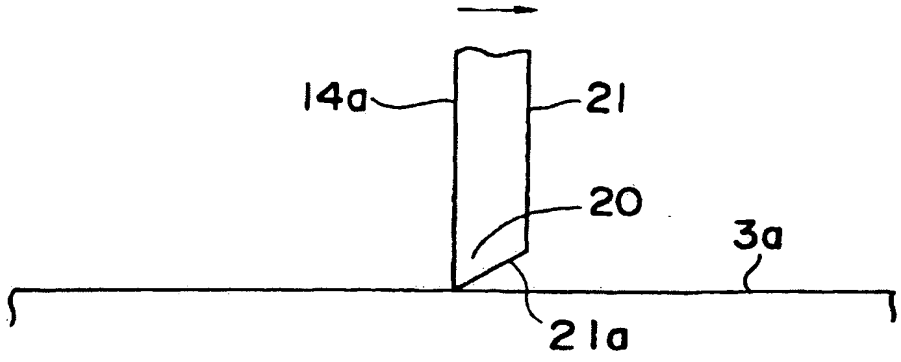


Fig. 17

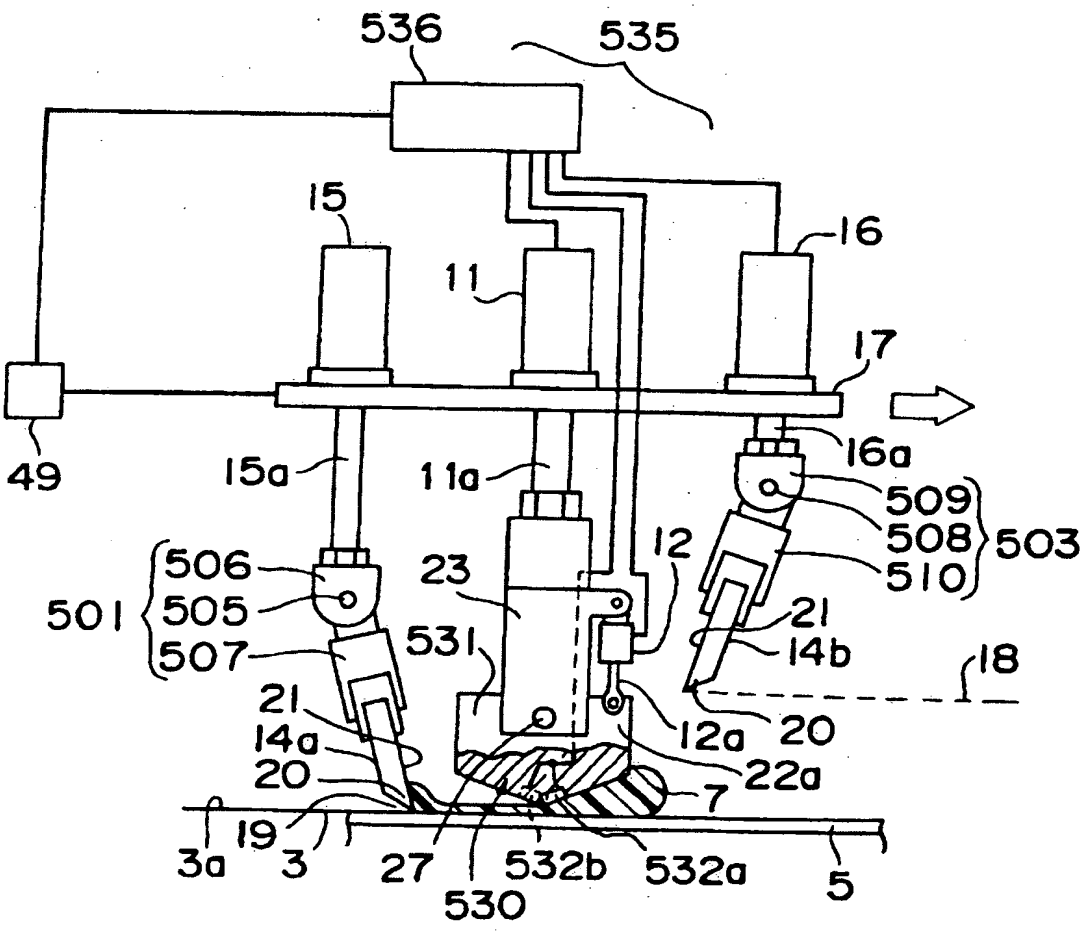


Fig. 18

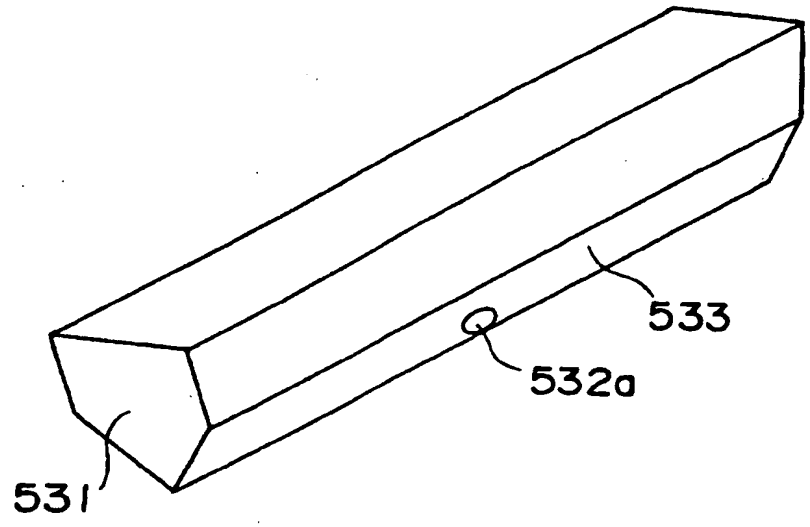


Fig. 19

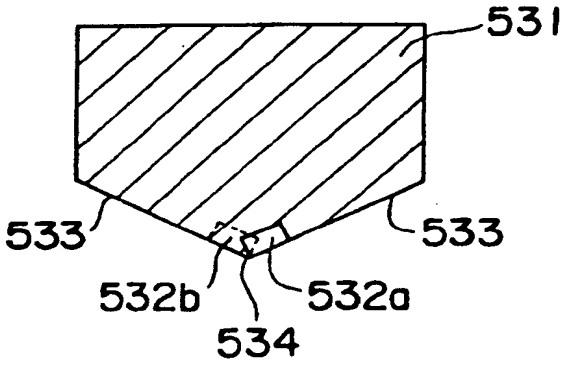


Fig. 20

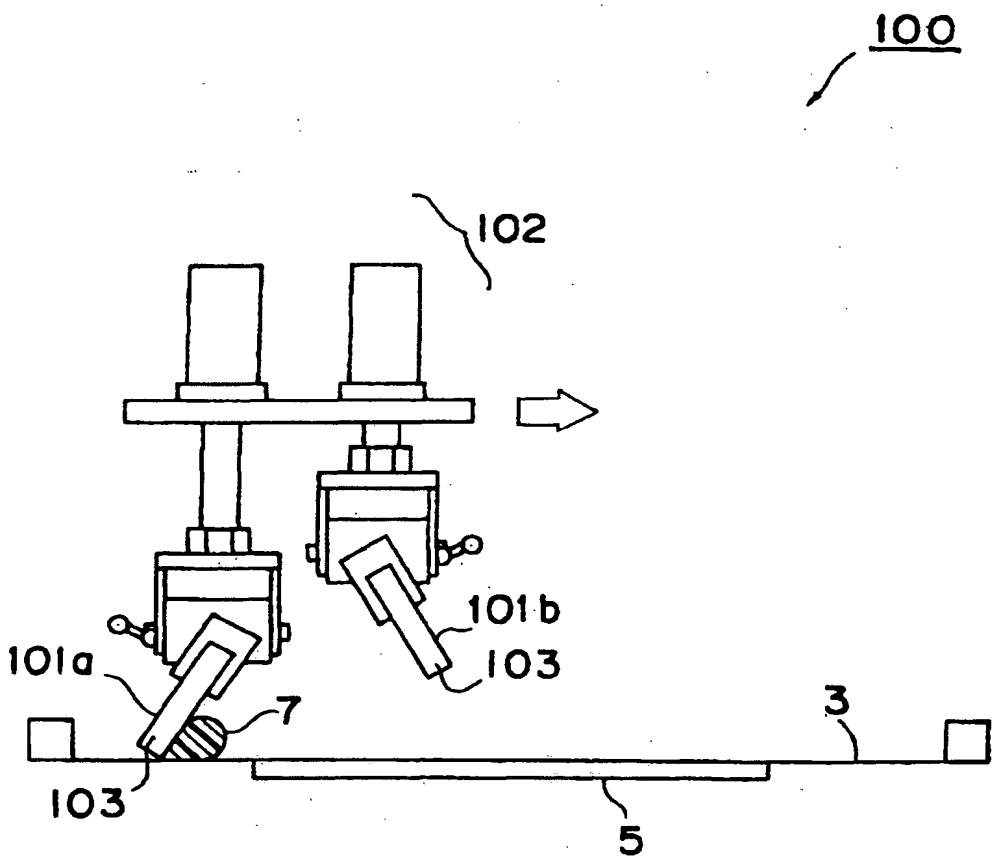


Fig. 21

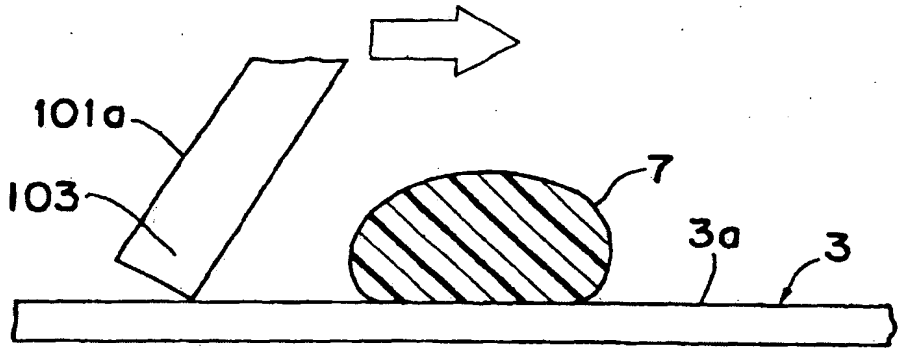


Fig. 22

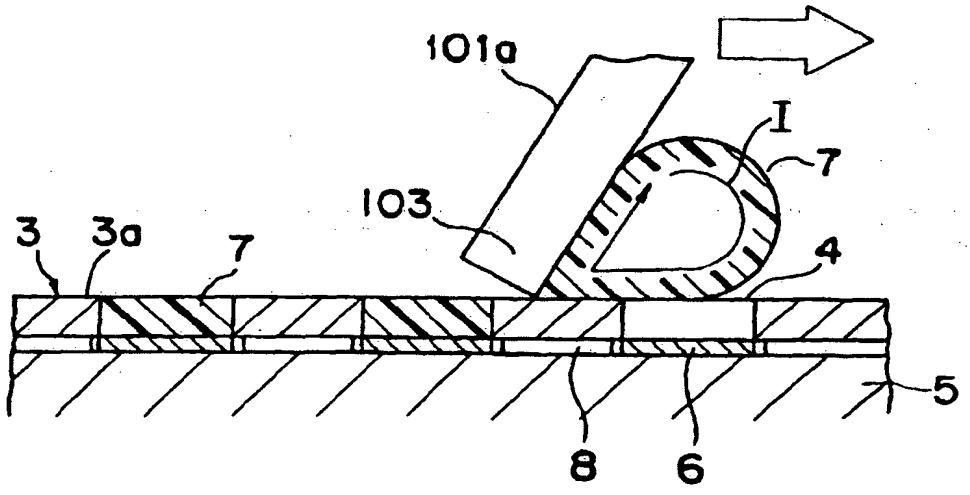


Fig. 23

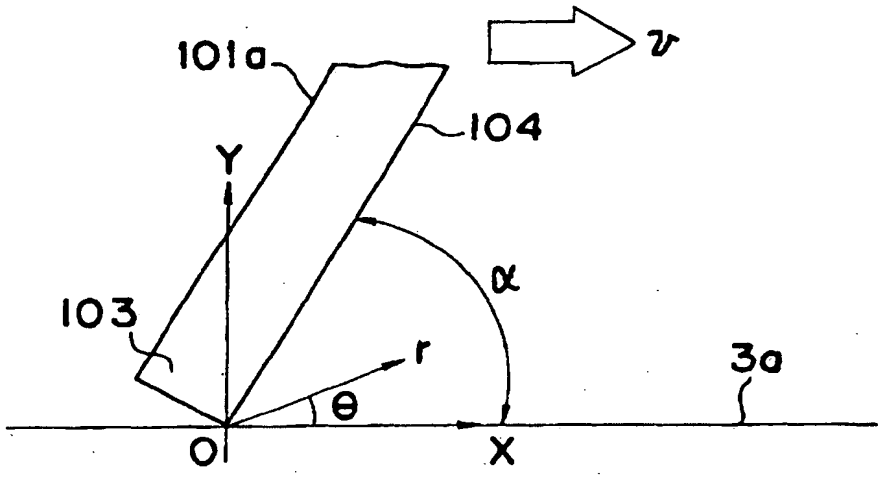


Fig. 24

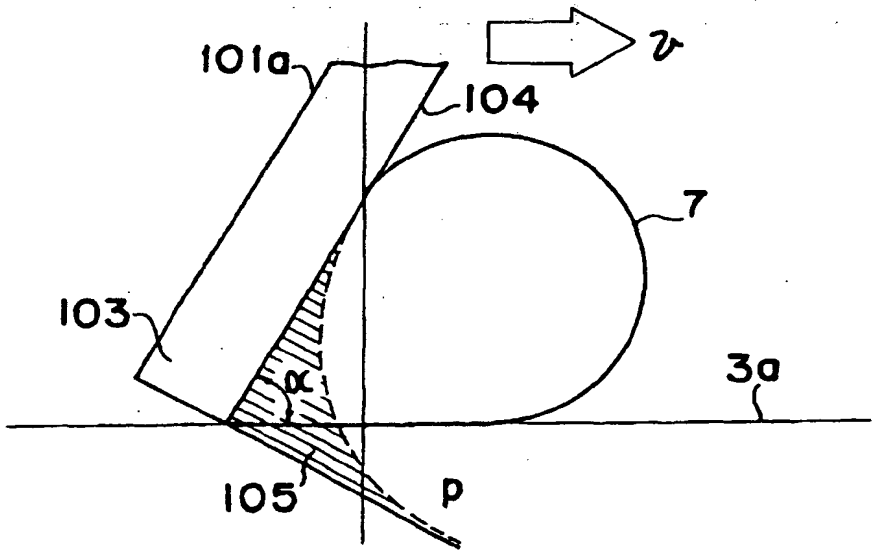


Fig. 25

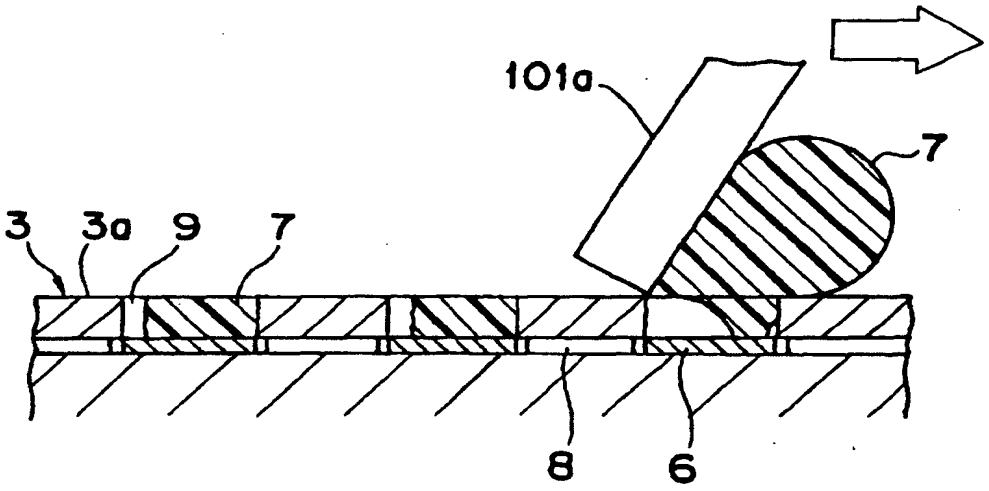


Fig. 26

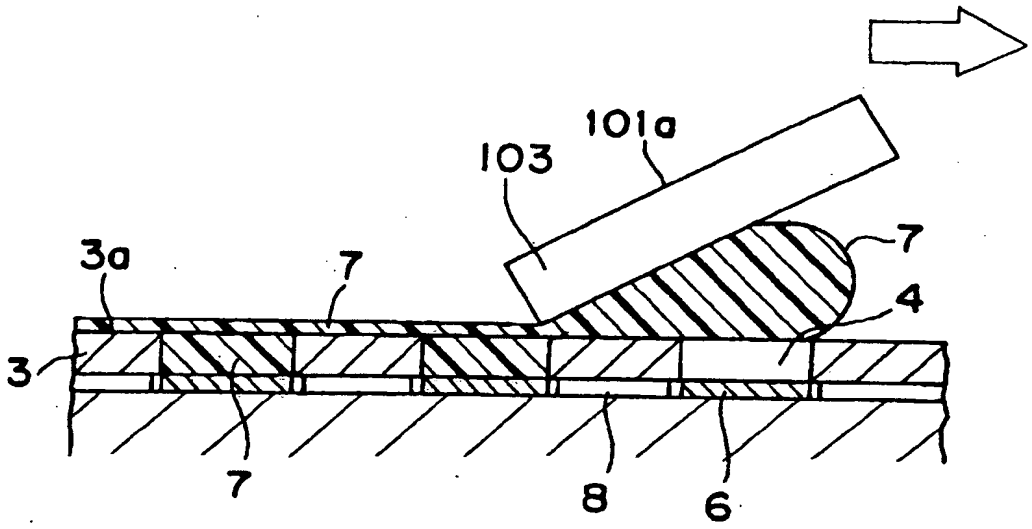


Fig. 27

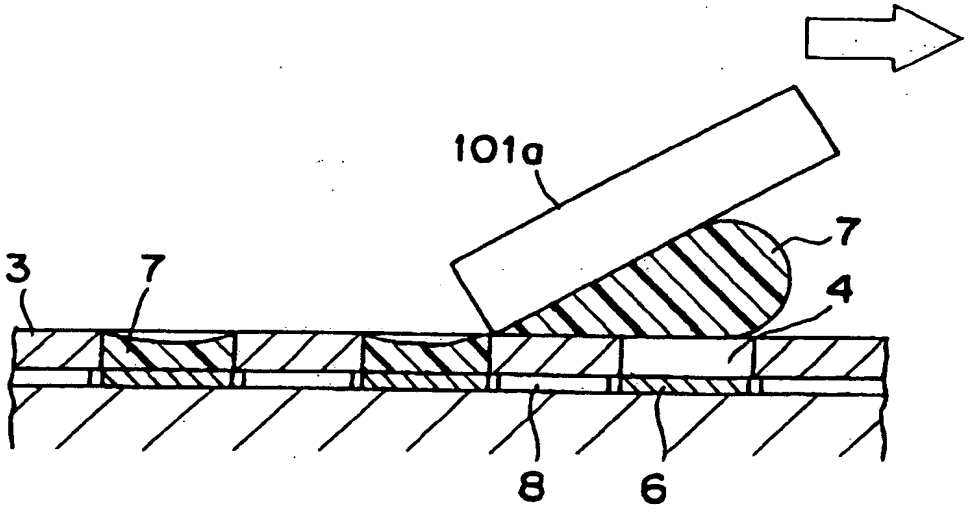


Fig. 28

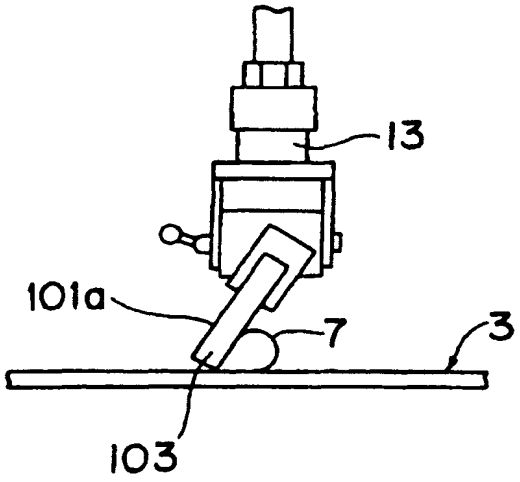
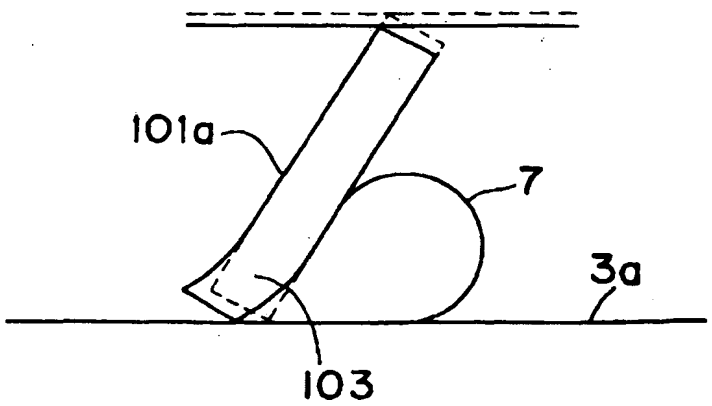


Fig. 29



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Application Number
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DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
Y	PATENT ABSTRACTS OF JAPAN vol. 96, no. 12, 26 December 1996 & JP 08 197712 A (MATSUSHITA ELECTRIC IND CO), 6 August 1996, * abstract *	1,2,4-9, 13-16, 18,19	H05K3/12 B41F15/46
Y	EP 0 071 014 A (FRITZ BUSER AG MASCHINENFABRIK) * claims; figures 1-9 *	1,2,4-9, 13-16, 18,19	
A	PATENT ABSTRACTS OF JAPAN vol. 16, no. 503 (M-1326), 16 October 1992 & JP 04 185340 A (MATSUSHITA ELECTRIC IND CO), 2 July 1992, * abstract *	1,2,4,6, 13,14,16	
A	PATENT ABSTRACTS OF JAPAN vol. 96, no. 5, 31 May 1996 & JP 08 025610 A (MATSUSHITA ELECTRIC IND CO), 30 January 1996, * abstract *	1,2,6, 13,16	
A	PATENT ABSTRACTS OF JAPAN vol. 16, no. 14 (E-1154), 14 January 1992 & JP 03 233994 A (MATSUSHITA ELECTRIC IND CO), 17 October 1991, * abstract *	1,6,13, 16	
A	PATENT ABSTRACTS OF JAPAN vol. 7, no. 189 (M-237), 18 August 1983 & JP 58 090981 A (DANTANI DANGYO KK), 30 May 1983, * abstract *	1,6,13, 16	

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TECHNICAL FIELDS SEARCHED (Int.Cl.6)
H05K
B41F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	16 March 1998	Mes, L

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DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	PATENT ABSTRACTS OF JAPAN vol. 96, no. 9, 30 September 1996 & JP 08 132588 A (FUJITSU TEN), 28 May 1996, * abstract *	1,2,13	
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A	US 5 493 969 A (TAKAHASHI ET AL.) * abstract *	7,17	
A	PATENT ABSTRACTS OF JAPAN vol. 17, no. 583 (E-1452), 22 October 1993 & JP 05 175646 A (MATSUSHITA ELECTRIC IND CO), 13 July 1993, * abstract *		TECHNICAL FIELDS SEARCHED (Int.Cl.6)

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	16 March 1998	Mes, L

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